# SCIENCE

FRIDAY, SEPTEMBER 24, 1909


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## SAMUEL WILLIAM JOHNSON

IN the death of Samuel William Johnson the chemists of America have lost one more from that small band who, two generations ago, undertook to extend and develop the beginnings which had been made to establish laboratories for instruction in chemistry and to apply this science to the industries of the country. Among these men, most of whom have already passed away, few left a greater impress on American chemistry or American chemists than did Professor Johnson, for his whole life was devoted to training workers in his chosen field, to making others realize what chemistry could do for them and to developing institutions and methods to extend the knowledge of chemistry and make this available to those engaged in productive occupations. The principal field to which he devoted his efforts was the application of science to agriculture, the results of which efforts are far better appreciated today, when the practical returns are so apparent than they were during the years of his greatest activity when he was patiently struggling against the conservatism of the so-called practical men who were persuaded with difficulty to make the beginning which was essential to demonstrate the truth of what he was trying to teach them.

Professor Johnson was born July 3, 1830, in Kingsboro, Fulton County, New York. His parents were of Connecticut origin but were taken by their parents to New York state when children. Although his father spent most of his active life in successful business he early retired to a large and fertile farm, soon after 1830,

and on this farm Professor Johnson spent his boyhood. He thus early became familiar with practical agriculture.

His father's training and experience in business led him to take a keen interest in the problems presented to the farmer and his discussion of such questions awakened an interest in his son to know more of the principles upon which the processes depended which he daily saw in progress about him.

At the age of ten he entered the Lowville Academy where he remained seven years and there came under the influence and instruction of David Porter Mayhew, who was an enthusiastic student of the natural sciences. Mayhew had then recently secured the means of establishing a chemical laboratory and in this laboratory Professor Johnson obtained his first knowledge of chemistry and, as he once wrote, "there became fascinated with chemistry through the brilliantly illustrated lectures of the principal." Mayhew made him his assistant, and, in 1846, presented him with a then recently published translation of Fresenius's Chemical Analysis. The possession of this book led him to equip a laboratory at his own home in which he prepared most of the reagents described, and worked through the qualitative course.

In his first note-book, dated June, 1848, he described his laboratory as nearly completed and begins with an account of his first attempt to prepare distilled water. This book contains many interesting accounts of the difficulties he encountered in preparing his reagents, and gives an insight into the training he thus got at the beginning of his chemical career which left its marked impress on his habits of work and thought throughout the remainder of his life.

The ability to rely on his own resources and to overcome difficulties by persistent effort soon developed a degree of self-confidence which enabled him to continue his studies in the face of difficulties which to most boys of his age would have seemed insurmountable. Although his father was interested in his chemical work he considered it an uncertain means for gaining a livelihood and opposed his son's determination to adopt it as his life work. He therefore undertook to show that he could support himself and so engaged in teaching in various schools at intervals for three years.

Having saved some money he entered the laboratory at Yale in 1850 and continued his studies with Benjamin Silliman and John P. Norton. His funds giving out, he again took up teaching and was so successful that his father became convinced that he had the capacity to take care of himself and decided to give him an opportunity to gain the education he had determined to secure.

After returning to Yale for another year he went abroad in 1853 and entered Erdmann's laboratory in June, where he stayed until the next April, studying various problems in organic and inorganic chemistry as well as attending lectures in other subjects. The next year he spent in Munich in the laboratory of Liebig and also studied with von Kobel and Pettenkofer. As a student at Munich he won the respect and friendship of Liebig, who followed with interest his later career and for several years after continued a correspondence with him. In 1855 he went to Paris, where he attended Chevereul's lectures. He spent the summer in England and worked for a short time with Frankland.

In September he returned to New Haven and took charge of the laboratory of the Yale Scientific School as chief assistant in

chemistry. The next year he was appointed to the new professorship of analytical chemistry. In 1857 he succeeded John A. Porter in the chair of agricultural chemistry and continued to give instruction in both these subjects until 1875, when he became professor of theoretical and agricultural chemistry. From 1870 until his retirement in 1895 he also gave instruction in organic chemistry.

Professor Johnson's agricultural work began while he was yet a student in his own laboratory in New York state. In 1847, when he was only seventeen years old, his first paper, "On fixing Ammonia," was published in the *Cultivator*. This was followed during the next few years by many other papers in this and other agricultural journals on various topics concerning the application of science to agriculture. After coming to Yale he continued his writings on agricultural science, and in 1856 read a paper to the Connecticut State Agricultural Society which led to his appointment as chemist to this society. In 1866 he became a member of the first Connecticut State Board of Agriculture and two years later its official chemist.

In 1873 he devoted his energies to the establishment of an agricultural experiment station in this state and spent much time visiting all parts of the state and arousing an interest in this subject. The work that he had done as chemist to the Agricultural Society and the State Board of Agriculture did much to make the advantages of such an institution evident to those engaged in farming. In 1877 an act was passed by the legislature establishing such an institution and he was appointed its director. The work that he had done for more than twenty years among the farmers of Connecticut had at last born fruit and the duty of organizing and developing the new institution occupied him, in addition to his college duties, during the twenty years succeeding.

Although the act incorporating the new station stated that its aim was "to promote agriculture by scientific investigation and experiment" his experience in bringing about its establishment showed him that it was necessary to devote a large part of his energies to work that would readily be recognized as of immediate pecuniary value to the farmer. Though his chief interest then, as always, lay in purely scientific research work on fundamental problems of agricultural science which he believed would be of greater value to agricultural practise, he felt it most important during the early years of the development of the institution to devote the larger part of its resources to such work as would win popular support for the institution. Most of his time, therefore, was given to establishing an effective fertilizer control and to improving the methods of practise on dairy farms and to perfecting the methods of agricultural analysis.

The limited resources of the station left little to be applied to the study of purely scientific problems, but such work as could be done along these lines was followed as far as possible, and to an increasing extent, as the resources of the station became larger. In his later years it was a constant source of regret that he was not able to take personal part in the research work which the federal funds now make possible in the institution he had founded. Many times he recalled to the writer the limited resources with which he had to work and expressed his regret that he had not been able to do the research work that he had for so long hoped to have the facilities to carry out.

By developing the details of station work and methods, by establishing high

standards of fair dealing both with the farmer and with those who supplied him, and by inspiring all who were associated with him with high ideals of scientific work he did more than any other man to make the experiment stations of the country the useful and successful institutions that they are. Those familiar with the details of his work can see the impress of what he did in countless ways in the methods now in use not only in the offices and laboratories of the other stations, but in many other laboratories devoted to other lines of work. His influence among those who have succeeded him in applying science to agriculture has been great, and he has had the pleasure of living to see others carrying out the plans which, in his youth, he hoped to carry out himself.

Professor Johnson achieved distinction not only as a teacher and as a promoter of agricultural science, but he won a high reputation among the legal profession by the great ability he showed as an expert in many important cases in court. The profound knowledge which he brought to bear on these cases, the great care and accuracy with which he performed the analytical work involved, the thoroughness with which he prepared every detail, and the clear and logical way in which he set forth his conclusions, have many times been recounted to the writer by leaders of the bar, and have always been accompanied with expressions of the highest admiration and respect for the ability he displayed.

Naturally of a retiring disposition and disinclined to acquire publicity by gaining positions of prominence in societies and public associations, he still took part with others in such organizations as he thought would contribute to the advancement of the sciences to which he was at heart devoted. Thus we find him at the age of twenty-one reading a paper before the American Association for the Advancement of Science of which he became a member at about this time. Later, in 1875, he was chairman of its sub-section of chemistry. In 1866 he was elected a member of the National Academy of Sciences and served on its committee on Sorghum sugar in 1881. He was long a member of the American Chemical Society and its president in 1878. He was one of the original members of the American Association of Official Agricultural Chemists and its president in 1888 and also president of the American Association of Agricultural Colleges and Experiment Stations in 1896.

Professor Johnson had a strong love of literature and was noted for his literary style and the simplicity and clearness with which he wrote. That this was a natural gift is evident from his paper "On the Houghite of Prof. Shepard," written when he was only twenty-one, in which he sets forth the results of his investigation with the skill of one who had had careful training and long experience in such work. His assured and finished style is shown in all his early contributions to the agricultural papers for which he wrote. That his most widely read book "How Crops Grow" was translated into nearly every civilized language was largely due to the purity and conciseness of the style in which it was written, for the character of this book was such that it would have been easy to rewrite the material into a new form and put it out as a new book.

While constantly occupied with scientific work Professor Johnson found time to keep himself informed of all that was new in nearly every branch of chemistry and agricultural science, and he also read much of general literature and of poetry, of which he had a high literary appreciation.

As a man Professor Johnson had a most

attractive personality which endeared him to all who were intimately associated with him. His kindly interest in his students and assistants and his many generous and helpful deeds in their behalf will long be remembered by those who had the good fortune to work with him.

THOMAS B. OSBORNE

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## *THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE*[1]

## *ADDRESS OF THE PRESIDENT TO THE PHYSIOLOGICAL SECTION*

### THE PHYSIOLOGICAL BASIS OF SUCCESS

DURING past years it has been customary for the presidents of sections in their addresses either to give a summary of recent investigations, in order to show the position and outlook of the branch of science appertaining to the section, or to utilize the opportunity for a connected account of researches in which they themselves have been engaged, and can therefore speak with the authority of personal experience as well as with that imparted by the presidential chair. The growing wealth of publications with the special function of giving summaries and surveys of the different branches of science, drawn up by men ranking as authorities in the subject of which they treat, renders such an interpretation of the presidential duties increasingly unnecessary, and the various journals which are open to every investigator make it difficult for me to give in an address anything which has not already seen the light in other forms. The association itself, however, has undergone a corresponding modification. Founded as a medium of communication between workers in different parts of the country, it has gradually acquired the not less important significance of a tribunal from which men of science, leaving for a time their laboratories, can speak to an audience of intelligent laymen, including under this term all those who are engaged in the work of the world other than the advancement of science. These men would fain know the lessons that science has to teach in the living of the common life. By standing for a moment on the little pinnacle erected by the physicist, the chemist or the botanist, they can, or should be able to, gain new hints as to the conduct of the affairs of themselves, their town or their state. The enormous advance in the comfort and prosperity of our race during the last century has been due to the application of science, and this meeting of the association may be regarded as an annual mission in which an attempt is made to bring the latest results of scientific investigation into the daily routine of the life of the community.

We physiologists, as men who are laying the foundation on which medical knowledge must be built, have as our special preoccupation the study of man. Although every animal, and indeed every plant, comes within the sphere of our investigations, our main object is to obtain from such comparative study facts and principles which will enable us to elucidate the mechanism of man. In this task we view man, not as the psychologist or the historian does, by projecting into our object of study our own feelings and emotions, but by regarding him as a machine played upon by environmental events and reacting thereto in a way determined by its chemical and physical structure.

Can we not learn something of value in our common life by adopting this objective point of view and regarding man as the latest result of a continuous process of evolution which, begun in far-off ages, has formed, proved and rejected myriads of types before man himself appeared on the surface of the globe?

[1] Winnipeg, 1909.

*Adaptation.*—In his study of living beings, the physiologist has one guiding principle which plays but little part in the sciences of the chemist and physicist, namely, the principle of adaptation. Adaptation or purposiveness is the leading characteristic of every one of the functions to which we devote in our text-books the chapters dealing with assimilation, respiration, movement, growth, reproduction, and even death itself. Spencer has defined life as "the continuous adjustment of internal relations to external relations." Every phase of activity in a living being is a sequence of some antecedent change in its environment, and is so adapted to this change as to tend to its neutralization and so to the survival of the organism. This is what is meant by adaptation. It will be seen that not only does it involve the teleological conception that every normal activity must be for the good of the organism, but also that it must apply to *all* the relations of living beings. It must therefore be the guiding principle, not only in physiology, with its special preoccupation with the internal relations of the *parts* of the organism, but also in the other branches of biology, which treat of the relations of the living animal to its environment and of the factors which determine its survival in the struggle for existence. Adaptation therefore must be the deciding factor in the origin of species and in the succession of the different forms of life upon this earth.

*Origin of Life.*—A living organism may be regarded as a highly unstable chemical system which tends to increase itself continuously under the average conditions to which it is subject, but undergoes disintegration as a result of any variation from this average. The essential condition for the survival of the organism is that any such disintegration shall result in so modifying the relation of the system to the environment that it is once more restored to the average in which assimilation can be resumed.

We may imagine that the first step in the evolution of life was taken when, during the chaotic chemical interchanges which accompanied the cooling down of the molten surface of the earth, some compound was formed, probably with absorption of heat, endowed with the property of polymerization and of growth at the expense of surrounding material. Such a substance could continue to grow only at the expense of energy derived from the surrounding medium, and would undergo destruction with any stormy change in its environment. Out of the many such compounds which might have come into being, only such would survive in which the process of exothermic disintegration tended towards a condition of greater stability, so that the process might come to an end spontaneously and the organism or compound be enabled to await the more favorable conditions necessary for the continuance of its growth. With the continued cooling of the earth, the new production of endothermic compounds would probably become rarer and rarer. The beginning of life, as we know it, was possibly the formation of some complex, analogous to the present chlorophyll corpuscles, with the power of absorbing the newly penetrating sun's rays and of utilizing these rays for the endothermic formation of further unstable compounds. Once given an unstable system such as we have imagined, with two phases, viz., (1) a condition of assimilation or growth by the endothermic formation of new material; (2) a condition of "exhaustion," in which the exothermic destructive changes excited by unfavorable external conditions came to an end spontaneously—the great principle of

natural selection or survival of the fittest would suffice to account for the evolution of the ever-increasing complexity of living beings which has occurred in the later history of this globe. The adaptations, *i. e.*, the reactions of the primitive organism to changes in its environment, must become continually more complex, for only by means of increasing variety of reaction can the stability of the system be secured within greater and greater range of external conditions. The difference between higher and lower forms is therefore merely one of complexity of reaction.

The naked protoplasm of the plasmodium of *Myxomycetes*, if placed upon a piece of wet blotting-paper, will crawl towards an infusion of dead leaves, or away from a solution of quinine. It is the same process of adaptation, the deciding factor in the struggle for existence, which impels the greatest thinkers of our times to spend long years of toil in the invention of the means for the offense and defense of their community or for the protection of mankind against disease and death. The same law which determines the downward growth of the root in plants is responsible for the existence to-day of all the sciences of which mankind is proud.

The difference between higher and lower forms is thus not so much qualitative as quantitative. In every case, whatever part of the living world we take as an example, we find the same apparent perfection of adaptation. Whereas, however, in the lower forms the adaptation is within strictly defined limits, with rise in type the range of adaptation steadily increases. Especially is this marked if we take those groups which stand, so to speak, at the head of their class. It is therefore important to try and find out by a study of various forms the physiological mechanism or mechanisms which determine the increased range of adaptation. By thus studying the physiological factors, which may have made for success in the struggle for dominance among the various representatives of the living world, we may obtain an insight into the factors which will make for success in the further evolution that our race is destined to undergo.

It is possible that, even at this time, objections may be raised to the application to man of conclusions derived from a study of animals lower in the scale. It has indeed been urged, on various grounds, that man is to be regarded as exempt from the natural laws which apply to all the other living beings. When we inquire into the grounds for assuming this anomic, this outlawed condition of man, we generally meet with the argument that man creates his own environment and can not therefore be considered to be in any way a product of it. This modification or creation of environment is, however, but one of the means of adaptation employed by man in common with the whole living kingdom. From the first appearance of life on the globe we find that one of the methods adopted by organisms for their self-preservation is the production of some artificial surroundings which protect them from the buffeting of environmental change. What is the mucilaginous envelope produced by microorganisms in presence of an irritant, or the cuticle or shell secreted by the outermost cells of an animal, but the creation of such an environment? All unicellular organisms, as well as the units composing the lowest metazoa, are exposed to and have to resist every change in concentration and composition of the surrounding water. When, however, a body cavity or *cœlom*, filled probably at first with sea-water, made its appearance, all the inner cells of the organism were withdrawn from the disturbing influence of variations in

the surrounding medium. The cœlomic fluid is renewed and maintained uniform in composition by the action of the organism itself, so that we may speak of it as an environment created by the organism. The formation of a body cavity filled with salt solution at once increased the range of adaptation of the animals endowed therewith. Thus it enabled them to leave the sea, because they carried with them the watery environment which was essential for the normal activity of their constituent cell units. The assumption of a terrestrial existence on most parts of the earth's surface involved, however, the exposure to greater ranges of temperature than was the case in the sea, and indicated the necessity for still further increase in the range of adaptation. Every vital process has its optimum temperature at which it is carried out rapidly and effectively. At or a little above freezing point the chemical processes concerned in life are suspended, so that over a wide range of the animal kingdom there must be an almost complete suspension of vital processes during the winter months, and at all times of the year a great dependence of the activity of these processes on the surrounding temperature. It is evident that a great advantage in the struggle for existence was gained by the first animals which succeeded in securing thermal as well as chemical constancy of environment for their cells, thus rendering them independent of changes in the external medium. It is interesting to note that the maintenance of the temperature of warm-blooded animals at a constant height is a function of the higher parts of the central nervous system. An animal with spinal cord alone reacts to changes of external temperature exactly like a cold-blooded animal, the activity of its chemical changes rising and falling with the temperature. In the intact mammal, by accurately balancing heat loss from the surface against heat production in the muscles, the central nervous system ensures that the body fluid which is supplied to all the active cells has a temperature which is independent of that of the surrounding medium. These are fundamental examples of adaptation effected by creation of an environment peculiar to the animal. Numberless others could be cited which differ only in degree from the activity of man himself. In some parts of this country, for instance, the activity of the beaver in creating an artificial environment has until lately been more marked than that of man himself. We are not justified, then, in regarding mankind as immune to the operation of natural forces which have determined the sequence of life on the surface of the globe. The same laws which have determined his evolution and his present position as the dominant type on the earth's surface will determine also his future destiny.

We are not, however, dealing with or interested in simple survival. Lower forms of life are probably as abundant on the surface of the globe as they were at any time in its history. Survival, as Darwin pointed out, is a question of differentiation. When in savage warfare a whole tribe is taken captive by the victorious enemy, the leaders and fighting men will be destroyed, while the slaves will continue to exist as the property of the victors. Survival, then, may be determined either by rise or by degradation of type. Success involves the idea of dominance, which can be secured only by that type which is the better endowed with the mechanisms of adaptation required in the struggle against other organisms.

Among the many forms of living matter which may have come into being in the earlier stages of the history of the earth,

one form apparently became predominant and must be regarded as the ancestor of all forms of life, whether animal or vegetable, viz., the nucleated cell. The almost complete identity of the phenomena involved in cell division throughout the living kingdom indicates that all unicellular organisms and all organisms composed of cells have descended from a common ancestor, and that the mode of its reproduction has been impressed upon all its descendants throughout the millions of years which have elapsed since the type was first evolved. The universal distribution of living cells renders it practically impossible for us to test the possibility of a spontaneous abiogenesis or new formation of living from non-living matter at the present time. We can not imagine that all the various phenomena which we associate with life were attributes of the primitive life stuff. Even if we had such stuff at our disposal, it would be difficult to decide whether we should ascribe the possession of life to it, and there is no doubt that any such half-way material would, directly it was formed, be utilized as pabulum by the higher types of organism already abounding on the surface of the globe.

*Integration and Differentiation.*—An important step in the evolution of higher forms was taken when, by the aggregation of unicellular organisms, the lowest metazoon was formed. In its most primitive forms the metazoon consists simply of a cell colony, but one in which all individuals are not of equal significance. Those to the outer side of the mass, being exposed to different environmental advantages from those within, must even during the lifetime of the individual have acquired different characteristics. Moreover, the sole aim of such aggregation being to admit of cooperation by differentiation of function between the various cell units, the latter become modified according to their position, some cells becoming chiefly alimentary, others motor, and others reproductive. Cooperation and differentiation are, however, of no use without coordination. Each part of the organism must be in a position to be affected by changes going on in distant parts, otherwise cooperation could not be effected. This cooperation in the lowest metazoon seems to be carried out by utilization of the sensibility to chemical stimuli already possessed by the unicellular organism. We have thus coordination by means of chemical substances ("hormones") produced in certain cells and carried thence by the tissue fluids to other cells of the body, a mechanism of communication which we find even in the highest animals, including man himself. To such chemical stimuli we may probably ascribe the accumulation of wandering mesoderm cells—*i. e.*, phagocytes—in an organism such as a sponge, around a seat of injury or any foreign substance that has been introduced. By this mechanism it is possible for distant parts of the body to react to stimulation of any one part of the surface. Communication by this means is, however, slow, and may be compared to the state of affairs in civilized countries before the invention of the telegraph, when messengers had to ride to different parts of the kingdom in order to arouse the whole nation for defense or attack.

*Foresight and Control.*—Increased speed of reaction and therefore increased powers in the struggle for existence were obtained when a nervous system was formed, by a modification of the cells forming the outer surface of the organism. By the growth of long processes from these cells a conducting network was provided, running through all parts of the body and affording a channel for the rapid propagation of

excitation from the surface to the deeper parts, as well as from one part of the surface to another. From this same layer were produced the cells which, as muscle fibers, would act as the motive mechanism of the organism. Thus, from the beginning, the chief means of attack or escape were laid down in close connection with the surface from which the stimuli were received. A further step in the evolution of the nervous system consisted in the withdrawal of certain of the sensory or receptor cells from the surface, so that a specially irritable organ, the central nervous system, was evolved, which could serve as a distributing center for the messages or calls to action initiated by changes occurring at the surface of the body. At its first appearance this central nervous system would hardly deserve the epithet of "central," since it formed a layer lying some distance below the surface, and extending over a considerable area; though we find that very soon there is an aggregation of the special cells to form ganglia, each of which might be regarded as presiding over the reactions of that part of the animal in which it is situated. Thus in the segmental worm-like animals a pair of ganglia is present in each body segment, and the chain of ganglia are united by longitudinal strands of nerve fibers to form the ganglionated cord, or central nervous system.

Such a diffused nervous system, in which all ganglia were of equal value, could, however, only act for the common weal of the whole body when a reaction initiated by stimulation at one part was not counteracted by an opposing reaction excited from another part of the surface. For survival it is necessary that in the presence of danger, *i. e.*, an environment threatening the life of the individual or race, the whole activities of the organism should be concentrated on the one common purpose, whether of escape or defense. This could be effected only by making one part of the central nervous system predominant over all other parts, and the part which was chosen for this predominance was the part situated in the neighborhood of the mouth. This, in animals which move about, is the part which always precedes the rest of the body, and therefore the part which first experiences the sense impressions, favorable or dangerous, arising from the environment. It is this end that has to appreciate the presence or approach of food material, as well as the nature of the medium into which the animal is being driven by the movements of its body. Thus a predominance of the front end of the nervous system was determined by the special development at this end of those sense organs or sensory cells which are *projicient* —*i. e.*, are stimulated by changes in the environment proceeding from disturbances at a distance from the animal. The sensory organs of vision and the organs which correspond to our olfactory sense organs and are aroused by minute changes in chemical composition of the surrounding medium, are always found especially at the front or mouth end of the organism. The chances of an animal in the struggle for existence are determined by the degree to which the responses of the animal to the *immediate* environment are held in check in consequence of stimuli arising from *approaching* events. The animal, without power to see or smell or hear its enemy, will receive no impulse to fly until it is already within its enemy's jaws. It must therefore be an advantage to any animal that the whole of its nervous system should be subservient to those ganglia or central collections of nerve cells which are in direct connection with the projicient sense organs in the head. This subservi-

ence is secured by endowing the head center with a power, firstly, of controlling and abolishing the activities (*i. e.*, all those aroused by external stimuli) of all other parts of the central nervous system, and, secondly, of arousing these parts to a reaction immediately determined by the impression received from the projicient sense organs of the head and originated by some change in the surroundings of the animal which has not yet affected the actual surface of its body.

*Education by Experience.*—The factors which so far determine success in the struggle for predominance are, in the first place, foresight and power to react to coming events, and, in the second place, control of the whole activities of the organism by that part of the central nervous system which presides over the reaction. The animal therefore profits most which can subordinate the impulses of the present to the exigencies of the future.

An organism thus endowed is still, however, in the range of its reactions, a long way behind the type which has attained dominance to-day. The machinery we have described, when present in its simplest form, suffices for the carrying out of reactions or adaptations which are determined immediately by sense impressions, advantage being given to those reactions which are initiated by afferent stimuli affecting the projicient sense organs at the head end of the animal. With the formation of the vertebrate type, and probably even before, a new faculty makes its appearance. Up to this point the reactions of an animal have been what is termed "fatal," not in the sense of bringing death to the animal, but as inexorably fixed by the structure of the nervous system inherited by the animal from its precursors. Thus it is of advantage to a moth that it should be attracted by, and fly towards light objects—*e. g.*, white flowers—and such a reactivity is a function of the structure of its nervous system. When the light object happens to be a candle flame the same response takes place. The first time that the moth flies into and through the candle flame, it may only be scorched. It does not, however, learn wisdom, but the reaction is repeated so long as the moth can receive the light stimuli, so that the response, which in the average of cases is for the good of the race, destroys the individual under an environment which is different from that under which it was evolved. There is in this case no possibility of educating the individual. The race has to be educated to new conditions by the ruthless destruction of millions of individuals, until only those survive and impress their stamp on future generations whose machinery, by the accumulation and selection of minute variations, has undergone sufficient modifications to determine their automatic and "fatal" *avoidance* of the harmful stimulus.

The next great step in the evolution of our race was the modification of the nervous system which should render possible the education of the individual. The mechanism for this educability was supplied by the addition, to the controlling sensory ganglia of the head, of a mass of nervous matter which could act, so to speak, as an accessory circuit to the various reflex paths already existing in the original collection of nerve ganglia. This accessory circuit, or upper brain, comes to act as an organ of memory. Without it a child might, like the moth, be attracted by a candle flame and approach it with its hand. The injury ensuing on contact with the flame would inhibit the first movement and cause a drawing back of the hand. In the simple reflex mechanism there is no reason why the same series of events should not be repeated indefinitely, as in the case of the moth. The central nervous system, how-

ever, is so constituted that every passage of an impulse along any given channel makes it easier for subsequent impulses to follow the same path. In the new nerve center, which presents a derived circuit for all impulses traversing the lower centers, the response to the attractive impulse of the flame is succeeded immediately by the strong inhibitory impulses set up by the pain of the burn. Painful impressions are always predominant. Since they are harmful, the continued existence of the animal depends on the reaction caused by such impressions taking the precedence of and inhibiting all others. The effect therefore of such a painful experience on the new upper brain must far outweigh that of the previous impulse of attraction. The next time that a similar attractive impression is experienced the derived impulse traversing the upper brain arouses, not the previous primary reaction, but the secondary one, viz., that determined by the painful impressions attending contact with the flame. As a result, the whole of the lower tracts, along which the primary reaction would have traveled, are blocked, and the reaction—now an educated one—consists in withdrawal from or avoidance of the formerly attractive object. The burnt child has learned to dread the fire.

The upper brain represents a nerve mechanism without distinct paths, or rather with numberless paths presenting at first equal resistance in the various directions. As a result of experience, definite tracts are laid down in this system, so that the individual has the advantage not only of his lower reflex machinery for reaction, but also of a machinery which with advance in life is adapted more and more to the environment in which he happens to be. This educable part of the nervous system—*i. e.*, the one in which the direction of impulses depends on past experience and on habit—is represented in vertebrates by the cerebral hemispheres. From their first appearance they increase steadily in size as we ascend the animal scale, until in man they exceed by many times in bulk the whole of the rest of the nervous system.

We have thus, laid down automatically, increased power of foresight, founded on the law of uniformity. The candle flame injures the skin once when the finger is brought in contact with it. We assume that the same result will follow each time that this operation is repeated. This uniformity is also assumed in the growth of the central nervous system and furnishes the basis on which the nerve paths in the brain are laid down. The one act of injury which has followed the first trial of contact suffices in most cases to inhibit and to prevent any subsequent repetition of the act.

*The Faculty of Speech.*—If we consider for a moment the vastness and complexity of the stream of impressions which must be constantly pouring into the central nervous system from all the sense organs of the body, and the fact that, at any rate in the growing animal, every one of these impulses is, so to speak, stored in the upper brain, and affects the whole future behavior of the animal, even the millions of nerve cells and fibers which are to be found in the human nervous system would seem to be insufficient to carry out the task thrown upon them. Further development of the adaptive powers of the animal would probably have been rendered impossible by the very exigencies of space and nutrition, had it not been for the development of the power of speech. A word is a fairly simple motor act and produces a correspondingly simple sensory impression. Every word, however, is a shorthand expression of a vast sum of experience, and

by using words as counters it becomes possible to increase enormously the power of the nervous system to deal with its own experience. Education now involves the learning of these counters and of their significance in sense experience; and the reactions of the highest animal, man, are for the most part carried out in response to words and are governed by past education of the experience-content involved in each word.

The power of speech was probably developed in the first place as a means of communication among primitive man living in groups or societies; as a means, that is to say, of procuring cooperation of different individuals in a task in which the survival of the whole race was involved. But it has attained still further significance. Without speech the individual can profit by his own experience and to a certain limited extent by the control exercised by the older and more experienced members of his tribe. As soon as experience can be symbolized in words, it can be dissociated from the individual and becomes a part of the common heritage of the race, so that the whole past experience of the race can be utilized in the education—*i. e.*, the laying down of nerve tracts—in the individual himself. On the other hand, the community receives the advantage of the foresight possessed by any individual who happens to be endowed with a central nervous system which transcends that of his fellows in its powers of dealing with sense impressions or other symbols. The foresight thus acquired by the whole community must be of advantage to it and serve for its preservation. It is therefore natural that in the processes of development and division of labor, which occur among the members of a community just as among the cell units composing an animal, a class of individuals should have been developed, who are separated from the ordinary avocations, and are, or should be, maintained by the community, in order that they may apply their whole energies to the study of sequences of sense impressions. These are set into words which, as summary statements of sequence, are known to us as the laws of nature. These natural laws become the property of the whole community, become embodied by education into the nervous system of its individuals, and serve therefore as the experience which will determine the future behavior of its constituent units. This study of the sequence of phenomena is the office of science. Through science the whole race thus becomes endowed with a foresight which may extend far beyond contemporary events and may include in its horizon not only the individual life, but that of the race itself as of races to come.

*Social Conduct.*—I have spoken as if every act of the animal were determined by the complex interaction of nervous processes whose paths through the higher parts of the brain had been laid down by previous experience, whether of phenomena or of words as symbolical of phenomena. The average conduct, however, of the individual, determined at first in this way, became by repetition automatic—*i. e.*, the nerve paths are so facilitated by frequent use that a given impulse can take only the direction which is set by custom. The general adoption of the same line of conduct by all the individuals of a community in face of a given condition of the environment gave in most cases an advantage to those individuals who were endowed with a nervous system of such a character that the path could be laid down quickly and with very little repetition. Thus we get a tendency, partly by selection, largely by education, to the establishment of reactions which, like the instincts of animals,

are almost automatic in character. As MacDougall has pointed out, the representations in consciousness of automatic tendencies are the emotions. Moral conduct, being that behavior which is adapted to the individual's position in his community, is largely determined by these paths of automatic action, and the moral individual is he whose automatic actions and consequent emotions are most in accord with the welfare of his community, or at any rate with what has been accepted as the rule of conduct for the community.

*Rise in Type dependent on Brain.*—Thus, in the evolution of the higher from the lower type, the physiological mechanisms, which have proved the decisive factors, can be summed up under the headings of integration, foresight and control. In the process of integration we have not only a combination of units previously discrete, but also differentiation of structure and function among the units. They have lost, to a large extent, their previous independence of action and, indeed, power of independent action, the whole of their energies being now applied to fulfilling their part in the common work of the organism. At first bound together by but slight ties and capable in many cases of separating to form new cell colonies, they have finally arrived at a condition in which each one is absolutely dependent for its existence on its connection with the rest of the organism and is also essential to the well-being of every other part of the organism.

This solidarity, this subjection of all selfish activity to a common end, namely, preservation of the organism, could only be effected by a gradual increase in the control of all parts by one master tissue of the body, whose actions were determined by impulses arriving from sense organs which themselves were set into activity by coming events. We thus have with the rise in type a gradually rising scale in powers of foresight, in control by the central nervous system, and in the solidarity of the units of which the organism is composed.

In the struggle for existence the rise in type has depended, therefore, on the central nervous system and its servants. Rise in type implies increased range of adaptation, and we have seen that this increased range, from the very beginning of a nervous system, was bound up with the powers of this system. Whatever opinion we may finally arrive at with regard to the types of animals which we may claim as our ancestors on the line of descent, there can be no doubt that Gaskell is right in the fundamental idea which has guided his investigations into the origin of vertebrates. As he says, "the law for the whole animal kingdom is the same as for the individual. Success in this world depends upon brains." The work by this observer which has lately appeared sets forth in greater detail than I have been able to give you today the grounds on which this assertion is based, and furnishes one of the most noteworthy contributions to the principles of evolution which have been published during recent years.

We must not, however, give too restrictive or common a meaning to the expression "brains" used by Gaskell in the dictum quoted above. By this word we imply the whole reactive system of the animal. In the case of man, as of some other animals, his behavior depends not merely on his intellectual qualities or powers, to which the term "brain" is often in popular language confined, but on his position as a member of a group or society. His automatic activities in response to his ordinary environment, all those social acts which we ascribe in our-

selves to our emotions or conscience, are determined by the existence of tracts in the higher parts of his brain, access to which has been opened by the ruthless method of natural selection and which have been deepened and broadened under the influence of the pleasurable and painful impressions which are included in the process of education. All the higher development of man is bound up with his existence as a member of a community, and in trying to find out the factors which will determine the survival of any type of man, we must give our attention, not to the man, but to the tribe or community of which he is a member, and must try to find out what kind of behavior of the tribe will lead to its predominance in the struggle for existence.

*Political Evolution.*—The comparison of the body politic with the human body is as old as political economy itself, and there is indeed no reason for assuming that the principles which determine the success of the animals formed by the aggregation of unicellular organisms should not apply to the greater aggregations or communities of the multicellular organisms themselves. It must be remembered, however, that the principles to which I have drawn your attention are not those that determine survival, but those which determine rise of type, what I have called success. Evolution may be regressive as well as progressive. Degeneration, as Lankester has shown, may play as great a part as evolution of higher forms in determining survival. The world still contains myriads of unicellular organisms as well as animals and plants of all degrees and complexity and of rank in the scale of life. All these forms are subordinate to man, and when in contact with him are made to serve his purposes. In the same way all mankind will not rise in type. Many races will die out, especially those who just fall short of the highest type, while others by degradation or differentiation may continue to exist as parasites or servants of the higher type.

Mere association into a community is not sufficient to ensure success; there must also be differentiation of function among the parts, and an entire subordination of the activity of each part to the welfare of the whole. It is this lesson which we English-speaking races have at the present time most need to learn. In the behavior of man almost every act is represented in consciousness as some emotion, experience or desire. The state of subordination of the activities of all units to the common weal of the community has its counterpart in consciousness as the "spirit of service." The enormous value of such a condition of solidarity among the individuals constituting a nation, inspired, as we should say, by this spirit of service, has been shown to us lately by Japan. In our own case the subordination of individual to state interests, such as is necessary for the aggregation of smaller primitive into larger and more complex communities, has always presented considerable difficulty and been accomplished only after severe struggle. Thus the work begun by Alexander Hamilton and Washington, the creation of the United States, is still, even after the unifying process of a civil war, incomplete and marred by contending state and individual interests. The same sort of difficulties are being experienced in the integration of the units, nominally under British control, into one great nation, in which all parts shall work for the good of the whole and for mutual protection in the struggle for survival.

*The Lesson of Evolution.*—Just as pain is the great educator of the individual and is responsible for the laying down of the

nervous paths, which will determine his whole future conduct and the control of his lower by his higher centers, so hardship has acted as the integrator of nations. It is possible that some such factor with its attendant risks of extermination may still be necessary before we attain the unification of the British empire, which would seem to be a necessary condition for its future success. But if only our countrymen can read the lesson of evolution and are endowed with sufficient foresight, there is no reason why they should not, by associating themselves into a great community, avoid the lesson of the rod. Such a community, if imbued by a spirit of service and guided by exact knowledge, might be successful above all others. In this community not only must there be subordination of individual to communal interests, but the behavior of the community as a whole must be determined by anticipation of events—*i. e.*, by the systematized knowledge which we call science. The universities of a nation must be like the eyes of an animal, and the messages that these universities have to deliver must serve for the guidance and direction of the whole community.

This does not imply that the scientific men, who compose the universities and are the sense organs of the community, should be also the rulers. The reactions of a man or of a higher mammal are not determined immediately by impulses coming from his eyes or ears, but are guided by these in association with, and after they have been weighed against, a rich web of past experience, the organ of which is the higher brain. It is this organ which, as the statesman of the cell community, exercises absolute control. And it is well that those who predicate an absolute equality or identity among all the units of a community should remember that, although all parts of the body are active and have their part to play in the common work, there is a hierarchy in the tissues—different grades in their value and in their conditions. Thus every nutritional mechanism of the body is subordinate to the needs of the guiding cells of the brain. If an animal be starved, its tissues waste; first its fat goes, then its muscles, then its skeletal structures, finally even the heart. The brain is supplied with oxygen and nourishment up to the last. When this, too, fails, the animal dies. The leading cells have first call on the resources of the body. Their needs, however, are soon satisfied, and the actual amount of food or oxygen used by them is insignificant as compared with the greedy demands of a working muscle or gland cell. In like manner every community, if it is to succeed, must be governed, and all its resources controlled, by men with foreseeing power and rich experience—*i. e.*, with the wisdom that will enable them to profit by the teachings of science, so that every part of the organism may be put into such a condition as to do its optimum of work for the community as a whole.

At the present time it seems to me that, although it is the fashion to acquiesce in evolution because it is accepted by biologists, we do not sufficiently realize the importance of this principle in our daily life, or its value as a guide to conduct and policy. It is probable that this doctrine had more influence on the behavior of thinking men in the period of storm and controversy which followed its promulgation fifty years ago, than it has at the present day of lukewarm emotions and second-hand opinions. Yet, according to their agreement with biological laws, the political theories of to-day must stand or fall. It is true that in most of them the doctrine of evolution is invoked as supporting

one or other of their chief tenets. The socialist has grasped the all-importance of the spirit of service, of the subordination of the individual to the community. The aristocrat, in theory at any rate, would emphasize the necessity of placing the ruling power in the hands of the individuals most highly endowed with intelligence and with experience in the affairs of nations. He also appreciates the necessity of complete control of all parts by the central government, though in many cases the sense organs which he uses for guidance are the traditions of past experience rather than the science of to-day. The liberal or individualist asserts the necessity of giving to each individual equal opportunities, so that there may be a free fight between all individuals in which only the most highly gifted will survive. It might be possible for another Darwin to give us a politic which would combine what is true in each of these rival theories, and would be in strict accord with our knowledge of the history of the race and of mankind. As a matter of fact the affairs of our states are not determined according to any of these theories, but by politicians, whose measures for the conduct of the community depend in the last resort on the suffrages of their electors—*i. e.*, on the favor of the people as a whole. It has been rightly said that every nation has the government which it deserves. Hence it is all-important that the people themselves should realize the meaning of the message which Darwin delivered fifty years ago. On the choice of the people, not of its politicians, on its power to foresee and to realize the laws which determine success in the struggle for existence, depends the future of our race. It is the people that must elect men as rulers in virtue of their wisdom rather than of their promises. It is the people that must insist on the provision of the organs of foresight, the workshops of exact knowledge. It is the individual who must be prepared to give up his own freedom and ease for the welfare of the community.

Whether our type is the one that will give birth to the super-man it is impossible to foresee. There are, however, two alternatives before us. As incoherent units we may acquiesce in an existence subordinate to or parasitic on any type which may happen to achieve success, or as members of a great organized community we may make a bid for determining the future of the world and for securing the dominance of our race, our thoughts and ideals.

E. H. STARLING

## *VACCINE THERAPY AND IMMUNIZATION*

Two of the great hospitals of London, as we learn from the London *Times*, St. Mary's, at Paddington, and the Mount Vernon Hospital for Consumption, at Hampstead and Northwood, have recently issued appeals on behalf of their special funds for the study and practise of vaccine therapy and for the further development of immunization.

At the Mount Vernon Hospital the direction of the department has been committed to Dr. R. W. Allen, who has been directing his attention largely to affording protection against catarrh and influenza, and who will be applying the same principles to the treatment and, it may reasonably be hoped, to the cure of the forms of tuberculosis of the lung which are still confined to a somewhat limited area. In these, as in tuberculosis of the joints, there is every reason to expect the ultimate subjugation of the invading bacilli by the natural forces evoked through the agency of inoculations; but, in the one case as in the other, the demand for special resources arises from the fact that the application of the principle involved has not yet been brought within the scope of merely bedside observation, and must still be guided by laboratory work of a kind which occupies much time and

requires very special training and skill for its performance.

At St. Mary's Hospital the new department is being controlled and financed by a special committee, separate from and independent of that of the hospital itself, and many members of this committee have guaranteed large contributions for a period of seven years. Sir Ernest Cassel gives £1,000 a year for this period, besides having contributed over £800 towards the equipment of the laboratory. Mr. William Bonn gives £500 a year for two years and £250 a year for five years more. Lord Justice Fletcher Moulton gives £250 a year for seven years. Lord Iveagh and Major Henry Davis have each contributed £1,000 to equipment expenses, and many donations of smaller amounts have been received; but there is still room for more if the objects of the department are to be completely secured. The appeal from Mount Vernon is also for money, which will be carried to a separate fund as a provision for the totally new class of expense which will be incurred; but we have not yet been informed of the character of the response which has been made to it. The methods and principles concerned are practically the same in both cases; and it is probable that the form of disease which attacks the lung will not be left without many sympathizing contributors to an effort which seems to hold out renewed hope to a considerable proportion of those who suffer from it.

### *THE NUMBER OF STUDENTS IN THE RUSSIAN UNIVERSITIES*

PROFESSOR B. MENSCHUTKIN, of St. Petersburg, writes to *Nature* in regard to the number of Russian students given by Professor Guido H. Marx in SCIENCE (May 14, 1909) as 23,000. He states that this number of students was reached some fifteen years ago, but at present the students of the higher colleges number at least 77,000, as can be seen from the following data, showing how many students there were in the different institutions in 1908 (in some cases, as for St. Petersburg, the numbers refer to the present year): *St. Petersburg* (University 9,800, Academy of Law 350, Philological Institute 150, Medical Academy 800, Technological Institute 2,000, Polytechnic Institute 4,200, Institute of Ways of Communication 1,200, Institute for Engineers 700, Electrotechnical Institute 650, Mining Institute 650, Institute of Forestry 550, the three higher colleges for women 6,000, Lyceum and three Military and two Nautical Academies 1,200, Academy of Theology 300), 28,550; *Moscow* (University 9,000, Institute of Oriental Languages 150, Academy of Theology 200, Technical Institute 2,500, Agricultural Institute 850, Engineering Institute 550), 13,250; *Kharkov* (University 5,300, Technological Institute 1,200, Veterinary Institute 500), 7,000; *Kiev* (University 3,200, Academy of Theology 200, Polytechnic Institute 2,500), 5,900; *Kazan* (University 3,000, Academy of Theology 170, Veterinary Institute 430), 3,600; *Tomsk* (University 800, Technological Institute 1,900), 2,700; *Warsaw* (University and Polytechnic Institute), 1,500; *Odessa* (University), 3,300; *Novocherkask* (Polytechnic Institute), 700; *Yuryev* (Dorpat) (University 3,000, Veterinary Institute 350), 3,350; *Helsingfors* (University 2,400, Technical College 350), 2,750; *Riga* (Polytechnicum), 1,700; *Novaya Alexandria* (Agricultural Institute), 400; *Yaroslavl* (Lyceum), 1,050; *Yekaterinoslav* (Mining Institute), 500; *Nězin* (Philological Institute), 150; *Saratov* (University, established this year), 200; *Vladivostock* (Institute of Oriental Languages), 300. The total number is therefore 76,900. There are also many private higher colleges in different towns, the number of students of which it is impossible to ascertain; it is surmised that this number is about 20,000.

### *SCIENTIFIC NOTES AND NEWS*

ON the occasion of the recent Leipzig celebration Dr. Wilhelm Wundt, the eminent psychologist, who made the principal address, was given the title of excellency. He was also made an honorary citizen of the city of Leipzig.

THE University of Birmingham will confer on October 20 a considerable number of doctorates of laws to commemorate the recent visit of King Edward. Among the scientific men to receive the degree are Sir William

Crookes, Sir Archibald Geikie, Dr. J. S. Haldane, reader in physiology at the University of Oxford; Sir Joseph Larmor, Lucasian professor of mathematics in the University of Cambridge; Sir William Ramsay, Lord Rayleigh, Professor E. Rutherford, professor of physics in the University of Manchester; Professor Silvanus P. Thompson, Dr. W. A. Tilden and Sir J. J. Thomson.

MR. CHARLES B. DUDLEY, of Altoona, Pa., chemist for the Pennsylvania Railroad Company, has been elected president of the International Congress on Testing Materials, which has been in session in Denmark and will hold its next meeting in New York in 1912.

IT is announced in *Nature* that Dr. A. du Pré Denning, for several years lecturer in experimental physics in the University of Birmingham, and principal of the Municipal Technical School, Smethwick, has been appointed by the secretary of state for India to the newly-created post of superintendent of industries and inspector of technical and industrial institutions in Bengal.

RECENT visitors at the Bureau of Plant Industry of the U. S. Department of Agriculture have been: Dr. Oskar Loew, late of the Porto Rico Experiment Station, who is now *en route* to Germany; Dr. H. T. Güssow, botanist of the Central Experiment Station, Ottawa, Canada; Mr. Aaronshon, director of the Agricultural Experiment Station in Palestine. Mr. Aaronshon is engaged in preparing a report on the dry-land crops of Palestine.

PROFESSOR JUNIUS HENDERSON, curator of the University of Colorado Museum, spent the first half of the summer vacation on the California coast, collecting marine material, both recent and fossil, and shipped to the museum a large collection, especially rich in series showing variation of species. He spent the latter part of the season in northwestern Colorado with three assistants, collecting biological and paleontological material, which is to form the basis for a report on that region. Dr. Francis Ramaley and Mr. W. W. Robbins did a considerable amount of field work for the same institution at Tolland, Colorado, where the mountain botanical laboratory is situated, and Professor T. D. A. Cockerell brought back valuable collections from Europe, where he spent the summer.

MR. WILLIAM MARCONI reached New York on the *Caronia* last week.

CAPTAIN ROALD AMUNDSEN, the Norwegian explorer, has decided to postpone his projected expedition to the Arctic regions until June 1, 1910.

WE learn from *Nature* that the Scottish expedition to Spitzbergen under Dr. W. S. Bruce has arrived at Tromsö on board the steam yacht *Conqueror,* with all well on board. The expedition, which left Leith in July, is reported to have completed the survey of Prince Charles Foreland and made important geological and other investigations.

LIEUTENANT SHACKLETON will give an account of his antarctic exploration in a series of lectures to be given in German and Austrian cities during the month of January next.

MISS MARIA PARLOA, born in Massachusetts in 1843, died at her home in Bethel, Conn., on August 21. She was widely known as a teacher and lecturer on cookery and other home economic topics. A careful observer, she contributed much which is of value to the science of food and nutrition. In addition to her popular lectures she gave instruction at schools and special work on the preparation of food for medical students. She was the author of many books and magazine articles on cookery and home economic topics, as well as of government bulletins on nutrition. She was a pioneer in the home economics movement in the United States in both its educational and practical sides and influential in introducing such subjects into the public schools.

M. L. BOUVEAULT, assistant professor of organic chemistry at the Sorbonne, Paris, has died at the age of forty-five years.

THE deaths are also announced of Professor V. F. Kremser, of the Berlin Meteorological Institute; of Dr. Franz Meschede, formerly professor of psychiatry at Königsberg, and of Dr. Fritz Erk, honorary professor of meteorology at Munich.

Dr. Brunhuber and Dr. Schmitz, German explorers, have been murdered by the primitive tribes on the Upper Salwin, in western Yunan.

The meeting of the American Physical Society for November 26 and 27, 1909, will be held in the new physics building of the University of Illinois, at Urbana-Champaign, Illinois.

The American School Hygiene Association and the American Physical Education Association meet with the Department of Superintendents of the National Education Association in Indianapolis during the last week of February, 1910.

The Third International Congress on School Hygiene is announced for Paris from March 29 to April 2, 1910.

The International Esperanto Congress, which has been meeting in Barcelona with an attendance of 1,300 delegates, has decided to hold its next session at Washington during August, 1910.

The select committee of the House of Commons has presented a report adverse to the daylight saving bill.

The daily papers state that a natural bridge spanning 274 feet and over 300 feet high, said to be the largest known, has been discovered by members of the Utah Archeological Society, which has returned from an expedition along the Colorado River in northern Arizona and southern Utah. The bridge is situated four miles north of the Arizona line in the state of Utah, six miles east of the Colorado River.

To encourage the photographing of the Leonids under favorable atmospheric conditions the Treptow Observatory, near Berlin, offers three prizes, the first of which is a telescope worth $40. The photographs must be made from a balloon, during the time from November 13 to 16, 1909, and the competition is open to the citizens of all nations. The original negatives awarded the prizes, together with all rights of publication, become the property of the illustrated periodical *Das Weltall*, published by the Treptow Observatory.

We learn from *Nature* that a movement has been started to unite entomologists in a congress entirely devoted to entomology in its various aspects, and to establish a permanent committee which may act as a central organization in the interest of this subject. It is proposed that a congress of entomology be held every three years, about a fortnight before each triennial zoological congress, so that resolutions and conclusions of general importance could, if deemed necessary, be brought up for discussion at the ensuing zoological congress. The first International Congress of Entomology will be held on August 1–16, 1910, at Brussels, during the International Exposition, which will be taking place there at that time. The subjects to be brought before the general or sectional meetings will comprise systematics, nomenclature, anatomy, physiology, psychology, ontogeny, phylogeny, ecology, mimicry, etiology, bionomy, paleontology, zoogeography, museology, medical and economic entomology. It will be remembered that the eighth International Congress of Zoology is to be held next year at Graz, Austria.

## *UNIVERSITY AND EDUCATIONAL NEWS*

The University of Pennsylvania proposes to erect during the coming year a building for its graduate school, costing $250,000.

Berea College receives $5,000 by the will of Dr. William P. Wesselhoeft, of Boston.

Mr. William E. Mott, associate professor of hydraulic engineering of the Massachusetts Institute of Technology, has been elected to take charge of the department of civil engineering at the Carnegie Technical Schools, Pittsburgh.

Mr. Heaton B. Robertson has been appointed instructor in mining and metallurgy in the Sheffield Scientific School of Yale University. In the same university Mr. Harry H. Wylie has been appointed assistant in psychology.

Dr. Jacob Kunz has been elected assistant professor of physics of the University of Illinois. Dr. Kunz is a graduate of the University of Zurich, and was for several years Privatdocent in mathematical physics in

Zurich. Later he spent a year in Cambridge with Professor J. J. Thomson. His courses at the University of Illinois will be in theoretical physics.

THE following are the new appointments in the scientific departments of the University of Kansas: Frederick E. Kester, professor of physics and head of the department; George C. Shaad, professor of electrical engineering and head of the department; Harry Gardner, assistant professor of sanitary engineering; Roy L. Moodie, assistant professor in zoology; Wilhelmina Bauer, instructor in mathematics; Jas. T. Bowles, instructor in pharmacy; H. J. Broderson, instructor in chemistry; Paul V. Faragher, instructor in chemistry; Arthur B. Frizell, instructor in mathematics; Meyer Gaba, instructor in mathematics; Florence Hedger, instructor in chemistry; Chester A. Johnson, instructor in physics; Nadine Nowlin, instructor in zoology; Howard A. Parker, instructor in civil engineering; George N. Watson, instructor in pharmacy; Paul Wernicke, instructor in mathematics; Bert C. Frichot, laboratory assistant in chemistry; Clifford P. Johnson, assistant instructor in physiology; C. A. Nash, assistant instructor in chemistry; E. R. Weidlein, assistant instructor in chemistry; Edward Wiedemann, assistant instructor in bacteriology.

A CHAIR of physical chemistry and metallurgy has been established at Frankfort to which Dr. Lorenz, of Zurich, has been called.

## *DISCUSSION AND CORRESPONDENCE*

### THE COUNTRY BOY

IN SCIENCE for July 2 Dr. Frederick Adams Woods replies to my article of May 7. I am very glad to learn from this article of Dr. Woods that we are not so far apart as I had suspected. I had thought that he claimed that practically heredity had everything and environment very little indeed to do with the development of character. Evidently I have misunderstood him, for in the article in question he indicates clearly that he believes that environment may produce profound results in character. Dr. Woods misinterprets part of what I said, or at least he does not get the idea which I meant to convey. Perhaps the fault is entirely my own. What I meant to say was that the environment of royalty is such as to give an opportunity for the full development of the natural tendencies of the individual and, therefore, in this class of people heredity will more nearly account for intellectual ability and moral character than it will in those classes of society who do not live under an environment that will give full opportunity for the development of the natural bent of the individual.

Since the publication of my last article I have been able to collect some data which is of interest in connection with the effect of farm life on the growing boy, and while these data are meager they seem to me to be favorable to the assumption that if other things could be equalized the life of the farm has a very distinct educational value. Dr. Woods has shown that at the time when the average man noted in "Who's Who" was a boy, about 16 per cent. of our population lived in the cities. He further showed that about 30 per cent. of the individuals in "Who's Who" were brought up in the city. He accounts for this excess of city men amongst men of note by the fact that the city attracts talent, the percentage of ability in the city, therefore, being greater than in the country. He would, therefore, explain the excess of city men mainly as the result of heredity. He may be correct in this position. I am inclined at present, however, to believe that while this excess may be partly due to the fact that talent is attracted to the city and that, therefore, the city child has a better chance of inheriting talent, part of it is due to the fact that the cities in general have better school facilities than the country. Most of the men in "Who's Who" are those who had good educational advantages. I suspect, therefore, that if an adequate study were made we should find that in this case environment has had something to do with the fact that 30 per cent. of the men in "Who's Who" are from the city. But for the sake of argument let us accept Dr. Woods's point of view. It would then follow that 30 per cent. of our leading men should be accredited to the city if their leadership is due entirely to heredity. Now for the facts in the

case. It is recognized that the following statistics are meager and that conclusions can only be drawn from them tentatively, but the fact that the figures are consistent with each other confirms their correctness. The following table gives statistics for the three classes of men who may be, perhaps, placed highest amongst the list of our leading men:

| Class of Men | City | Country and Village | Per Cent. from Country |
|---|---|---|---|
| Presidents ....... | 2 | 23 | 92.0 |
| Governors ....... | 4 | 41 | 91.2 |
| Cabinet officers ... | 9 | 47 | 83.9 |
| Totals ........ | 15 | 111 | 88.2 |

The figures for presidents include all the presidents this country has had. Of course in the early days a smaller proportion of our population lived in the cities. But this criticism can not be applied to the list of governors. Figures for this class of men relate to the present governors of the states. It is seen that 91.2 per cent. of this class of men are from the country or village. The figures for cabinet officers include members of cabinets between 1869 and 1903. The average of these three classes of men shows 88.2 per cent. of them from the country. Now, if we accept Dr. Woods's view that the cities furnish a larger proportion of our leading men for the reason that talent is attracted to the city, the proportion of these men coming from the country should be considerably less than the proportion of our population in the country, but the facts show that the proportion of these men from the country is actually greater than the proportion of country population. This seems to me to argue strongly for farm life as an educational force. In the case of governors, of the forty-five who answered my queries four were born and reared in the city, seven of them in country villages and thirty-similar data for the other classes.

I have received replies from forty-seven railway presidents in this country. Of these 55.4 per cent. are credited to the village and country. When we remember that preferment in this industry is greatly influenced by hereditary wealth it seems to me that the fact that so large a percentage of these men are country bred is somewhat significant. Statistics for members of the house of representatives are of less value for our present purpose than most of the other statistics given here, for the reason that nativity is a distinct force in politics, and that many representative districts are wholly city while others are wholly country districts. Sixty-four per cent. of the present members of the house of representatives are from the country. Figures for members of the senate are of more value in this respect, since senators represent states. Yet the fact that most of our senators are very wealthy men would seem to justify the inference that the city has more than its share of this class of men, yet 70.6 per cent. of the eighty-five members of the present senate for whom data could be obtained are from the country. Taking all six of these classes of men, the average per cent. from the country is 69.4. It will be noted that the higher we go in the scale of leadership in those classes which are least influenced by extraneous considerations, the higher is the per cent. of country-bred men. I believe these figures substantiate the claim made in my original article, namely, that country life has a distinct educational value. But what is it in country life that gives this advantage? President Lucius Tuttle, of the Boston and Maine Railroad, in answering my circular letter answers this question. He says:

> Among other things, the farm boy learns methods of economy and, incidentally, the value of money. He is a part of the business machinery of the farm and is brought into close contact with all its affairs. He learns methods of trade and how to buy and sell, as well as possible, without incurring losses and, later on when he leaves the farm and goes into a general business, the education he has acquired during his farm life becomes a fundamental and valuable part of his after business life.
>
> As a general rule, the city boy has no connection with his father's business and knows nothing about it. His father may be eminently successful but the boy has nothing to do with making his success and is very seldom allowed to be cognizant of the methods of business his father uses. Under modern conditions, school life gives the boy very little business knowledge and, at the end of his

school education, when he enters business, he is obliged to begin at the bottom of the ladder without knowledge of many things that the farm boy has learned in connection with his daily home life.

To my mind this is the fundamental reason why boys brought up on the farm appear to make better successes in their after business life than do city boys who have not had the advantages of a similar business training in their earlier days.

President White, of the Richmond, Fredericksburg and Potomac Railroad Company, in discussing the effect of life on the farm, says:

It is preeminently, in my judgment, an experience which develops independence and self-reliance and, therefore, I think, the spirit of achievement, more than any other I know of.

Another railroad president remarks:

I believe that farm life lays a good and broad foundation for a healthy, vigorous manhood in both mind and body.

Another noted railway man, who never spent a day on the farm, says:

I am inclined to think boys brought up on the farm have better constitutions and are less liable to temptations.

President L. W. Hill, of the Great Northern Railway, says:

My present home is on a farm and my principal reason for making my home there, rather than at some of the lakes or in the city, is that I have three boys of my own I am trying to give a fair start in life. I believe there is no end of arguments that living on the farm gives the best chance for a growing boy. While my making the farm my home sometimes works an inconvenience to me, I realize that the benefits to my children are well worth the inconvenience to me of getting in and out between my office and the farm.

I have always contended that the value of farm rearing lies in the fact that on the farm there is a chance to place responsibility on the growing boy. I firmly believe that it is possible to work out a system of education that will give our schools all the advantages of the farm life. This is being done, to a certain extent, in the cities, and I believe that this fact has something to do with the increasing number of strong men who come from the city. But I must admit that the actual data on this subject are very meager and I join Dr. Woods in the hope that some careful student will give this question the investigation which its importance demands.

W. J. SPILLMAN

U. S. DEPARTMENT OF AGRICULTURE

### DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

I REGRET to find that several errors were made in compiling the statistics of the doctorates conferred by American universities (SCIENCE for August 20). The number of degrees conferred by Wisconsin was sixteen (not seven), of which four were in the sciences. There were five degrees (not three) in geology conferred by Yale with geology as the major subject. On page 266, column 2, line 4, Michigan should be substituted for Washington. The assistant who compiled the data is not without excuse for these errors; for example, in the case of Wisconsin the doctorates conferred are given in two different places on the commencement program without any cross references. But I regret the occurrence of errors in statistics which I believe have hitherto been free from them.

J. MCKEEN CATTELL

### THE NOMENCLATORIAL COURT

TO THE EDITOR OF SCIENCE: Some weeks ago Mr. Francis N. Balch called attention in the columns of SCIENCE to the need of a court for determination of questions in zoological nomenclature. It appears that the International Congress of Zoologists has appointed a Nomenclature Commission of which Dr. C. W. Stiles, of Washington, is secretary, which performs the functions of such a court although its work is still far from being well developed or appreciated.

It appears that the International Congress has not made any appropriation for the expenses of this court whose labors have hitherto been carried on as a work of love. As the business before the court has accumulated the need of a paid clerk becomes urgent. As I understand the International Congress has no means of raising funds for the carrying on of the business of its committee, it is obviously the duty of those who most directly profit by the activities of the committee to pay a tax

for the salary of such a clerk. I understand from Dr. Stiles that $1,200 would pay for the salary of a clerk. I would suggest, therefore, that ten of the leading Museums of the United States pay each $60 toward this expense and that $60 be paid by ten museums of Europe. Those in America to be the National Museum and those at Cambridge, Boston, New York, Brooklyn, Philadelphia, Pittsburgh, Chicago, Milwaukee, San Francisco. It would, of course, have to be recognized that this charge would be an annual one.

If the great museums of this country would thus voluntarily pay such a tax, the court of reference for questions of zoological nomenclature would become permanently established.

CHAS. B. DAVENPORT

## SCIENTIFIC BOOKS

*Igneous Rocks*. By JOSEPH P. IDDINGS. Vol. I., Composition, Texture and Classification. 8vo, xi + 464 pages, 130 figures and two colored plates. New York, John Wiley & Sons. 1909.

It is not often that a work appears in the literature of any science which stands out so clearly from other corresponding works in respect to both its point of view and its intrinsic value that it must be accorded the rank of epoch making. But such is the fact in the writer's opinion concerning the volume by Professor Iddings which is the subject of this notice. Here is a treatise on igneous rocks which does not in the least pattern after the numerous works on the subject, but from the outset follows a new plan. The author has studied the igneous rock with the aid of modern developments in physics and chemistry and makes the understanding of composition and texture in the light of those developments the all-important thing.

The point of view of the author may be in a measure inferred from the order in which the properties of igneous rocks are presented, and the manner in which they are discussed in Part I., on Composition and Texture. The igneous rock is, of course, the product of the consolidation of a molten magma. The fundamental property which the rock shares with the magma from which it was derived is its chemical composition. Hence the work presents in Chapters I. and II. the characteristic facts as to the chemical composition of the rocks and of their constituent minerals. Groups of rock analyses are given and a full statement of the various devices used by petrographers to represent in diagrams the significance of the varying amounts of different components shown by analysis. Two colored plates represent many hundred analyses by means of diagrams of Iddings's own design.

A departure from the usual procedure in discussing the chemical composition of rock minerals is made by taking up the chemical elements known to occur in rocks and, considering them in groups of Mendeléeff's table, indicating the mineral into which they are likely to enter under the associations and restrictions of the case.

The fact that an igneous rock is derived from highly complex molten solution by crystallization is to the author abundant reason for insisting that the petrographer should understand the principles of physics and chemistry applicable to rock magmas and Chapter III. is devoted to this subject. Special attention is given to the properties of magmas as solutions, and to the chemical reactions which may take place under certain conditions in solutions, expressed in the terms of modern physical chemistry.

Following this general discussion is one in which the chemical reactions likely to take place in rock magmas under the conditions prevailing in the crustal zone of the earth are particularly considered. Taking the thirteen constituents which are prominent in most igneous rocks the controlling influence of relative chemical activity, strength of combination, affinity of certain elements for each other, and the effect of differing proportions of the elements, are considered in their bearing on the formation of observed rock minerals. To a large extent the reasons for the abundance of certain mineral molecules and the rarity of others containing the same substances are plain. The laws which control the common association of some minerals, the apparently antithetical relations of others, and the de-

velopment of rare combinations are discussed.

In Chapter V. Iddings gets at the meat of the matter as to the formation of the rock from the magma. The rock is formed by the separation of solid, liquid and gaseous substances from the magma, crystallization of minerals being the principal process. This change from the magmatic solution to the solid rock may take place in one or several periods, at one or several levels in the crust of the earth or at the surface. The conditions under which different stages of consolidation take place are constantly changing, not only from the circumstances of environment incident to eruption but from the changes connected with partial crystallization and various disturbances of chemical equilibrium. It is beyond the limits of this notice to review this important chapter in detail and an enumeration of the principal headings must suffice to show the method of treatment.

The separation of gases, liquids and solids is discussed. Under the latter the principal causes of separation are considered—such as the addition or loss of substances, lowering of temperature and changes of pressure. Saturation and supersaturation as influenced by changes in temperature, and the metastable and labile conditions of solutions, are treated in sections. Then comes the discussion of Number of Points of Separation, The Rate of Separation, The Effect of Viscosity on the Rate of Separation, Polymorphic Substances, The Order of Separation, Effect of Supersaturation on Order of Separation, Separation of Isomorphous Compounds, Zonal Structure and Eutectic Mixtures of More Than Two Compounds.

The author refers to the subject-matter of this chapter in these words:

> From the foregoing it appears that the solidification with crystallization of rock magmas must be an extremely intricate process, involving variable or irregular changes in temperature and pressure consequent on the movements of eruption, together with variations in composition chiefly through changes in gaseous components, and the possibilities of chemical reaction among the components with changing chemical equilibria, and the probabilities of supersaturation of the magma by different components to various degrees.

The origin of mineral composition of the rock having been discussed, there is taken up, in Chapter VI., the question of crystallization and resultant texture. Here again the treatment logically consists in showing the effect of a great range of changing or variable conditions in determining texture. After discussing the genesis of the formal relations of the parts of a rock Iddings describes the textures of igneous rocks under the divisions Crystallinity, Granularity and Fabric, using the terms which have recently been proposed[1] to supplement the inadequate terminology in current use. The illustrations used in this chapter are particularly good and tend to emphasize the desirability of greater precision and refinement in the description of igneous rock textures.

Differentiation of Rock Magmas is the subject of Chapter VII. The evidences of differentiation are first presented with regard to the visible relations of parts of a single rock mass on the one hand, and as exhibited by many relations which connect the various rocks of a petrographic province on the other. Having established by the citation of facts that the petrographer must recognize in various rock series or groups the products of differentiation from a parent magma, Iddings proceeds to the discussion of processes and hypotheses concerning them. It is notable that this discussion is sane and conservative. The author advocates no hypothesis or speculation without a plausible basis in the laws of physics and chemistry, which has sometimes been done by prominent leaders in the science. On the contrary, the conditions which have been operative on the magmatic solution at various stages of its history are examined to find influences which may have led to differentiation, of different degrees and kinds. The effects of changes in density, viscosity, molecular concentration and saturation, are discussed, to show that they may under certain circum-

[1] "The Texture of Igneous Rocks," by Cross, Iddings, Pirsson and Washington, *Jour. Geol.*, Vol. 14, 1906, pp. 692–707.

stances favor differentiation. Instances in nature which seem to be explainable by these processes are cited. Contemporaneous veins and pegmatic veins are considered by Iddings as resulting from differentiation and a hypothetical explanation for each is given. The facies of composition and texture exhibited by many igneous masses are examined in their relation to differentiation.

The solution of rock by liquid magma is considered, with the conclusion that evidences of this absorption within the zone available to our examination are rare. Hybrid or mixed rocks are given a brief mention, and a concise historical review of hypotheses of differentiation is given. In a short but interesting sketch of the course of magmatic eruption Iddings shows some of the phases or periods which may be supposed to favor magmatic differentiation.

The last chapter of Part I. is devoted to a description of the modes of occurrence of igneous rocks. Here the course of treatment naturally follows that of other treatises. Numerous excellent and new illustrations add greatly to the attractiveness of this chapter.

Part II. of the volume deals with "Nomenclature and Classification," truly a most difficult subject at the present time. On many sides one may hear expressions of extreme dissatisfaction with the existing condition of systematic petrography and its terminology. But we are in a perfectly natural, though most uncomfortable, stage in the evolution of the science. The man who understands the essence of the igneous rock, as presented by Iddings, can best comprehend that nomenclature and classification to-day are in confusion because it could not be otherwise.

Iddings first reviews the growth of the prevalent nomenclature and of the classifications it expresses. The facts are familiar to petrographers and they are presented by the author in a way to emphasize the conclusion that with such a history the existing confusion is simply the logical result.

In one chapter Iddings sketches the prevalent system—if system it can be called—under the term "Qualitative Mineralogical System." For the presentation of this system Iddings has recourse to the usual tabular scheme, inserting the names to be defined in their appropriate spaces. Then follows a definition of each name in terms of mineral composition and texture. These definitions are essentially as they may be found in the works of Rosenbusch and Zirkel, except the expression of genetic ideas attached by the former. These same names are used with similar signification by German, French, English, American and other petrographers in spite of more or less different bases of classification.

In the final chapter of the volume Iddings presents a statement of the "Quantitative Classification of Igneous Rocks" of which he is a co-author.[2] Here is given a criticism of the qualitative mineralogical system and a discussion of the available bases of classification, leading to the choice of chemical composition as the foundation of the quantitative system. This follows closely the original presentation of the system, but is accompanied by many references to facts brought out in earlier parts of the book.

Taken as a whole this volume leads directly to the quantitative system as the only one yet devised by means of which the petrographer may adequately and correctly express the relations of igneous rocks in regard to their absolute, determinable properties as objects. The discussion of the origin of mineral composition and texture is certainly thorough enough to demonstrate the author's deep interest in petrogenesis, but it also serves to show that the complexities, if not the uncertainties, of genetic relations render them unavailable as bases of a truly systematic classification of all igneous rocks.

The work is written from a standpoint occupied to some extent by other specialists, but which must henceforth be familiar ground to every petrographer worthy of the name. Not that one must agree with Iddings in all respects, but that the study and the scientific discussion of igneous rocks must be based on

[2] "Quantitative Classification of Igneous Rocks," by Cross, Iddings, Pirsson and Washington, The University of Chicago Press, 1903.

the fullest recognition of the extremely complex magmatic solutions from which they have come and of the varied conditions determining the characters of the rocks themselves, and not infrequently producing rocks of different mineral composition from a single magma.

This volume is a treatise on igneous rocks which is manifestly an unfettered expression of the author's understanding of them rather than a text-book. Yet it outlines so logically the view of these objects which the student should be made to understand that it may be used as the basis of instruction in all advanced courses.

The book appears in uniform style with "Rock Minerals" by the same author. The second volume, descriptive of known rocks, is in preparation, and will be awaited with interest and with the hope that the author may be successful in making his subject more attractive than is the case with existing literature of the kind. WHITMAN CROSS

*Railroad Structures and Estimates.* By J. W. ORRUCK, C.E. New York, John Wiley & Sons. 270 pages, 94 illustrations. $3 net.

Probably the primary purpose of this book is to furnish data for estimating the various parts of a railroad, and it contains a compilation of cost data which should prove of value to many a young engineer, not only in furnishing reasonable figures of costs, but also in stimulating him to secure similar figures for his own locality or from his own railroad. Costs vary from time to time and also locally, so that figures for estimates can not safely be swallowed whole either from this book or any other. A book of this sort then should find its best value in suggesting methods of cost estimation, and in analyzing the constituent parts of costs. This book is somewhat uneven from this standpoint, some chapters having the elements of cost well classified, while others are very general, as in the costs of tunnels where a short table of costs per lineal foot is quoted from Drinker's rather ancient treatise; while the estimates for turnouts are itemized, the cost of a split switch is given as $30 to $50; and similarly for laying and surfacing it, $30 to $50; a variation of considerable amount without special explanation to account for it. The criticism applies perhaps to the difficulty of the subject rather than to inferiority of treatment.

The compilation of cost data involves a knowledge of the structures or materials to be built or used; as a result a large share of the book is given to such descriptions, or sometimes practically specifications. There are given, also, a number of tables which seem hardly consistent with the general purpose of the book; among these are one "for putting in frogs and switches," others for "feet head and equivalent pressure in pounds per square inch," "friction of water in pipes," "friction of water in elbows"; also a table of "horsepower."

The chapter on buildings, covering eighty-eight pages, is quite largely given to descriptions, and these cover many classes of buildings; it has not quite the merit of a treatise and yet any one is likely to find there some thing he wants and which is worth while. In the estimates of this chapter, some are well analyzed and itemized, while some others are very general and with wide range of cost values, a freight shed with modern floors being estimated at 25 to 50 cents per square foot.

The chapter on Specifications and Contracts, covering thirty-one pages, is inadequate, and except for four pages on estimates, hardly in line with the apparent purpose of the book.

The book in its mechanical make-up has the general appearance and quality of the Wiley books on engineering, which means that it is satisfactory. The scope is indicated by the following Chapter Index:

I. Track Materials. II. Fences, gates, sign posts. III. Culverts. IV. Bridges. V. Buildings. VI. Water Stations. VII. Tanks. VIII. Specifications and Contracts. IX. Estimating Notes.

C. F. ALLEN

*Neuere Ergebnisse auf dem Gebiete der Speziellen Eiweisschemie.* PROF. EMIL ABDERHALDEN. Jena, Verlag v. Gustav Fischer.

"Die Neueren Ergebnisse auf dem Gebiete

der Speziellen Eiweisschemie" first appeared as a chapter in the "Handbuch der Biochemie" edited by Karl Oppenheim. The entire subject of proteins was treated in that "Handbuch" by several authors, and it was the part of Professor Abderhalden to present that phase of the progress in protein-chemistry which was made possible through the new analytical and synthetical methods, introduced by Emil Fischer.

Professor Abderhalden was a close associate of Emil Fischer during the time when the work was in progress and that makes the chapter more vivid and authoritative than any other on the subject of protein chemistry, written for the Oppenheimer Handbuch.

The work on protein chemistry of Fischer and his school falls into two large groups: one which brought to light the elementary components of the protein molecule, and the second, which elucidated the character of their linkage in the protein molecule. The first was in its nature principally analytical, the second synthetical. The work in either direction was preceded by a careful study of the properties of some derivatives of aminoacids. In course of this study Fischer introduced an improvement into the method of Curtius for preparing the ethylesters of the aminoacids from their hydrochlorides. This made possible the distillation of the esters and their separation one from another in a convenient, neat and comparatively rapid manner. The part assigned by Fischer to Abderhalden and his coworkers was to apply this process to the separation of the aminoacids obtained on the cleavage of nearly every protein known in nature. A part of the book contains a complete and concise account of all this work.

The property of the esters of the aminoacids to form anhydrides of the acids was the basis for the synthetic formation of peptides. It is safe to say that this discovery was the most important phase in the development of protein chemistry, since it contained the key to our knowledge of the manner in which individual aminoacids are linked in the protein molecule.

The original method of peptid synthesis was later improved through the introduction of the halogenacyl synthesis which led to the formation of optically active peptides. This new achievement in its turn opened the way to the study of the configuration of peptides and of the relation of configuration to the action of proteolytic enzymes. The book of Abderhalden gives a complete account of all these achievements in a very concise form. The properties of all known aminoacids and their derivatives are described in a manner which makes the work serve as a valuable reference book. The analytical methods are also described, though not always in minute detail. All this makes the book very serviceable to the investigator, and at the same time it gives a good survey of the development of our knowledge of the chemical structure of the protein molecule. The physical properties of the proteins and the character of their primary cleavage products are not discussed by Abderhalden.

P. A. Levene

The Rockefeller Institute
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## *SCIENTIFIC JOURNALS AND ARTICLES*

The opening (October) number of volume 16 of the *Bulletin of the American Mathematical Society* contains the following papers: "Note on Fermat's Numbers," by J. C. Morehead and A. E. Western; "An Extension of Certain Integrability Conditions," by J. E. Wright; "Necessary Conditions that Three or More Partial Differential Equations of the Second Order shall have Common Solutions," by C. A. Noble; "Note on Determinants Whose Terms are Certain Integrals," by R. G. D. Richardson and W. A. Hurwitz; "On the Tactical Problem of Steiner," by W. H. Bussey; "On the So-called Gyrostatic Effect," by A. S. Chessin; "A Continuous Group related to Von Seidel's Optical Theory," by A. C. Lunn; "Shorter Notices": Runge's Analytische Geometrie der Ebene, by M. Bôcher; Netto's Gruppen- und Substitutionentheorie, by W. B. Fite; Czuber's Einführung in die höhere Mathematik, by C. L. E. Moore; Ball-FitzPatrick's Recréations mathématiques, by D. E. Smith; Pockel's

Lehrbuch der Kristalloptik, by E. B. Wilson; "Notes"; "New Publications."

## SPECIAL ARTICLES

### ON MAGNETIZATION BY ANGULAR ACCELERATION

Some time ago, while thinking about the origin of the earth's magnetism, it occurred to me that any magnetic substance must, according to current theory, become magnetized by receiving an angular velocity.

Thus consider a cylinder of iron or other substance constituted of atomic or molecular systems whose individual magnetic moments are not zero. The simplest ideal system of this kind is of course a negative (or positive) electron revolving about a positive (or negative) center. In its initial state the magnetic moment of the cylinder composed of all the systems is zero. If, however, it is given an angular acceleration about its axis, the resulting torque on each individual system will cause its orbit to change its orientation, or the revolving part its speed, in such a way as to contribute a minute magnetic moment parallel to the axis of the cylinder, all the systems, if alike, contributing moments in the same direction. If the revolving electrons are negative, as appears at least generally to be the case, the cylinder will become magnetized as it would be by an electric current flowing around it in a direction opposite to that of the angular velocity imparted to it.

Early in July I began some experiments on this subject, using slightly modified apparatus constructed originally for other purposes. These experiments appear to show the effect in question in the case of a large steel rod, the intensity of magnetization resulting when an angular speed of about 90 revolutions per second was produced being about $1/1500$ c.g.s. unit, in the direction indicated by theory on the assumption that the revolving electrons are negative. This effect, if substantiated by later work, will account for a minute part of the earth's magnetism, but, apparently, for only a minute part. It is the converse of the effect which has been looked for recently by Richardson.

Superposed on this effect was another, perfectly definite and unquestionable, but exceedingly difficult to account for, viz., a magnetization along the rod in a definite direction independent of the direction of rotation and of the direction of the original residual magnetism of the rod. It was not due to the jarring of the cylinder as it was rotated in the earth's field, nor to a possible minute change in the direction of its axis produced by the pull of the motor. In magnitude this effect was several times as great as the other, which became manifest only at the higher of the two speeds used.

The observations were made inductively with a ballistic galvanometer. The throws were very small, but definite, and were in opposite directions for starting and stopping.

Later on I hope to investigate this subject more thoroughly with apparatus designed for the purpose. I am sending this account to you because of the importance of one of the effects mentioned, and the fact that some months must elapse before a thorough investigation can be undertaken.

S. J. BARNETT

August 5, 1909

### NITRIFYING BACTERIA IN NORTH CAROLINA SOILS

IN a recent number of SCIENCE[1] Stevens and Withers present some interesting data concerning the existence in North Carolina of non-nitrifying soils. It was pointed out that 71 per cent. of 62 soil samples representing, with few exceptions, normal agricultural soils near the North Carolina Agricultural Experiment Station failed to nitrify, a state of affairs considered anomalous.

At the time of the publication of this paper the Laboratory of Soil Bacteriology of the Bureau of Plant Industry was receiving a number of soil samples from fields or plots where legume inoculation experiments were in progress. Thirty samples from crimson clover fields in North Carolina (representing nineteen counties) were submitted to a test for nitrification. Seven samples were from the Piedmont Plateau and twenty-three from the coastal-plain region.

[1] SCIENCE, N. S., XXIX., No. 743, p. 506.

The method used consisted in determining the amount of ammonium sulphate the soil would convert into nitrate during an incubation of eight days. The soils were first spread out on a clean sheet of paper and allowed to become air dry, being carefully protected against dust during this time. To 50 grams of this soil was then added a quantity of 0.4 per cent. ammonium sulphate (about 5 c.c.) sufficient to bring the moisture content to (or a little below) the optimum for plant growth.[2] No tests were carried on in solutions, it having been our experience that nitrifying bacteria do not act normally in test solutions. This fact has also been reported by Stevens and Withers.[3] The amount of nitrates found minus the amount originally found in the soil represents the action of nitrifying bacteria on the ammonium sulphate solution.

The table shows the nitrates found by this method to have been formed in thirty North Carolina farm soils.

Six tests of soil samples from other localities are included for comparison. It will be seen that while our results substantiate the point that nitrification is at a rather low ebb in North Carolina soils, yet nitrifying bacteria are generally present, and if supplied with suitable food would undoubtedly soon multiply sufficiently to cause a normal rate of nitrification.

A comparison of samples nos. 7 and 8 is interesting: no. 7, having a low nitrifying power, was from a portion of a field where crimson clover formed no nodules, and the soil gave a pink reaction; no. 8, showing fairly active nitrification, was from another portion of the same field, gave no reaction to litmus, and root nodules occurred in average numbers. This is typical of much unpublished data upon soils from other regions and leads us to believe that nitrification, nodule formation upon certain species of legumes, and the litmus reaction are correlated.

NITRIFICATION IN NORTH CAROLINA SOILS

| No. | Locality. Post-office in North Carolina | Nitrate in Original Sample. p.p.m. | Nitrate Formed in Eight Days from Ammonium Sulphate p.p.m. |
|---|---|---|---|
| 1 | Cameron | trace | 40 |
| 2 | Dunn | 25 | 100 |
| 3 | LaGrange | trace | 62 |
| 4 | Roseboro | " | 125 |
| 5 | Richfield | 60 | 125 |
| 6 | Ahoskie | 12 | 110 |
| 7 | Wilson | 0 | 20 |
| 8 | Wilson | 0 | 82 |
| 9 | Salemburg | 0 | 40 |
| 10 | Gates | trace | 75 |
| 11 | Shine | " | 98 |
| 12 | Fayetteville | 1 | 33 |
| 13 | Pisgah | trace | 75 |
| 14 | Hobbsville | " | 50 |
| 15 | Farmville | " | 50 |
| 16 | Hayesville | " | 50 |
| 17 | Durham | " | 60 |
| 18 | Farmville | " | 80 |
| 19 | LaGrange | 1 | 77 |
| 20 | Sandy Ridge | trace | 1 |
| 21 | Jamesville | 1 | 125 |
| 22 | Haynes | 0 | 95 |
| 23 | Ayden | 0 | 34 |
| 24 | Roxobel | trace | 25 |
| 25 | LaGrange | 4 | 150 |
| 26 | Pink Hill | trace | 59 |
| 27 | Ashboro | " | 42 |
| 28 | Tarboro | 0 | 1 |
| 29 | Moretz | trace | 102 |
| 30 | Gatesville | " | 32 |
| 31 | Lanham, Md. | " | 300 |
| 32 | " " | " | 100 |
| 33 | " " | " | 500 |
| 34 | " " | " | 225 |
| 35 | Edgerton, Kan. | 160 | 400 |
| 36 | New Cambria, Mo. | 80 | 500 |

Karl F. Kellerman,
T. R. Robinson
Bureau of Plant Industry,
Washington, D. C.

[2] The samples were placed in salt-mouth bottles stopped with a wet plug of cotton to maintain even moisture conditions, and were incubated eight days at 30° C. Distilled water (100 c.c.) was then added to the soil, bottles shaken for fifteen minutes, allowed to settle, filtered, and the clear solution tested by the phenol-disulphonic acid method, as described in Bureau of Soils Bulletin No. 31, p. 40.

[3] Science, N. S., XXVII., No. 704, p. 991.

## *SECOND ANNUAL SPRING CONFERENCE OF THE GEOLOGISTS OF THE NORTHEASTERN UNITED STATES*

On April 23 and 24 a conference of the geologists of the northeastern United States was held in Philadelphia, Pa., at the invitation of the Mineralogical and Geological Section of the Academy of Natural Sciences. Two sessions for pre-

sentation of papers were held on the first day, and a field trip to typical localities of the pre-Cambrian and early Paleozoic rocks of the region on the second day. After an address of welcome by Dr. Edward J. Nolan, secretary of the academy, seven papers were read, as follows:

*The Lower Cambrian of Lancaster County, Pa.:* H. JUSTIN RODDY, State Normal School, Millersville, Pa.

The rocks of the Lancaster Valley comprise quartzite, argillite and limestone, in all of which abundant fossils have recently been discovered, including many of the typical forms of the Olenellus fauna. The argillites, in particular, contain magnificently preserved examples of *Olenellus thompsoni* and *Holmia walcotti*. No Middle or Upper Cambrian fossils have as yet been found, but the limestones are overlain on the north by shales of "Hudson River" type, at the base of which traces of Ordovician forms have been observed. Because of complicated structure, the thickness of the Lower Cambrian is not certainly known, but it probably exceeds 3,000 feet.

*The Pre-Cambrian Gneisses of the Pennsylvania Piedmont Plateau:* MISS BASCOM, Bryn Mawr College.

Of the crystalline rocks of this district the gneisses present the more serious difficulties in the determination of age, origin and stratigraphic relations.

There has been determined the following succession of pre-Cambrian gneisses: hornblende gneiss, granite gneiss, Wissahickon mica gneiss, Baltimore gneiss.

*The Baltimore gneiss*, underlying the Paleozoic series, to the lowest member of which it has furnished débris, exhibits two facies: a massive facies presumably of igneous origin and a sedimentary facies peripheral in position.

*The Wissahickon mica gneiss* exhibits many facies, due to the injection and impregnation of a sedimentary formation of somewhat varying composition, but always characterized by an excess of mica. This gneiss is adjacent to, or overlying the Paleozoic series, but is considered to be separated from them by a thrust fault for the following reasons:

1. While the gneiss persists over great areas, the adjacent Paleozoic series change from one member of the series to another and in the thickness of single members.

2. The gneiss shows a coarser crystallization than the adjacent Paleozoics. It is contrasted with the Ordovician mica schist, a formation of similar composition with which it is in contact for long distances, from which the gneiss can always be separated by a greater degree of metamorphism and by structure.

3. The Wissahickon gneiss, like the Baltimore gneiss, is thoroughly intruded by chonoliths of granite, gabbro, pyroxenite and peridotite, which are not found intruded in the Paleozoics.

*The hornblende and granite gneisses* are manifestly igneous in origin, intrusive in character and younger than the other gneisses.

*The Medina and Shawangunk Problems in Pennsylvania:* A. W. GRABAU, Columbia University.

The Formation No. IV. of the Pennsylvania Surveys is not all of the same age, as formerly supposed, but comprises two entirely distinct groups of formations. The lower of these includes the Bald Eagle conglomerate, well exposed in the westernmost of the Appalachian ridges, which is of Upper Ordovicic, approximately of Eden age; the Juniata red-beds, corresponding to the Queenstown shales of western New York, of late Lorraine and Richmond age; and the Tuscarora sandstone, the equivalent of the true Medina, marking the base of the Siluric. In the easternmost of the ridges, the Blue Mountain, the conglomerate is the Shawangunk, which is known to be of Salina age; and this is followed by the Longwood shales and they in turn by the Lewistown limestone, which is uppermost Siluric. The conglomerates and shales are believed to be of continental origin, representing the alternation of torrential deposits with flood plain and æolian deposits under semi-arid climates. Their geographical distribution shows them to have the form of great alluvial fans, deposited by rivers flowing from the southeast; and the occasional intercalated fossiliferous beds represent the temporary advance of the sea upon the margins of the fans.

*The Buried Gorge of the Hudson River:* W. O. CROSBY, Massachusetts Institute of Technology.

*Glacial Erosion in Great Britain, France and Switzerland:* DOUGLAS WILSON JOHNSON, Harvard University.

This paper discussed two questions: (1) Are hanging tributary valleys a reliable indication of glacial erosion of the main valley? (2) May not hanging tributary valleys result from glacial *widening* of the main valley, instead of from glacial *deepening?* It was shown that while the formation of hanging valleys by normal stream

erosion is possible under certain conditions, the occurrence of hanging valleys of this type is exceptional, and their peculiar origin may be detected by associated physiographic features. It was concluded that in general hanging tributary valleys of the common type are to be regarded as proof of glacial erosion. A study of the relations normally existing between stream valleys and their tributaries proves that hanging tributary valleys of any length can hardly be produced by glacial widening of the main valley, and that where such hanging valleys exist a significant amount of glacial over-deepening must be inferred. A method of estimating the actual amount of glacial over-deepening of valleys with a fair degree of accuracy was described, and the application of this method to glaciated valleys in Europe was discussed. Glacial over-deepening amounting from 600 to over 1,000 feet was found to have occurred in three of the valleys studied.

On the basis of this study it was concluded that no account of drainage modifications in glaciated regions could be regarded as complete if it failed to take account of the possible changes due to glacial erosion. The relation of this study to the drainage problems in western New York, and to engineering problems in the gorge of the Hudson River, was briefly touched upon.

*The Early Paleozoic of the Lehigh Valley District, Pennsylvania:* Edgar T. Wherry, Lehigh University.

Contrary to the usual opinion, it has been found that the Cambrian and Ordovician portions of the Great Valley limestones in this district can be readily distinguished on a lithologic basis, five formations being recognizable between the Hardyston quartzite of Lower Cambrian age and the Martinsburg shale of Lower Trenton to Utica age, as follows (local names being provisionally applied, and the thicknesses roughly estimated): Leithsville formation, Lower-Middle Cambrian, gray dolomite with abundant sandy and cherty layers, and buff-colored shale beds, 1,500 feet. Allentown limestone, Upper Cambrian, white to gray, dolomitic, largely oolitic, full of Cryptozoon, 2,000 feet. Coplay limestone, Beekmantown, dark gray, shaly, with mottled crystalline layers, numerous fossils, 1,500 feet. A marked erosion interval occurs here, so that the whole thickness of the Coplay is rarely seen. Nisky formation, Black River, gray, very shaly limestone, probably never exceeding 100 feet in thickness. Nazareth cement rock, Lower Trenton, varying from 500 feet or more down to zero, being replaced westward and southward by the Martinsburg shale. The presence of two small areas of Shawangunk conglomerate, preserved by down-faulting some twenty miles south of the main exposure in the Blue Ridge, corresponding in position and lithologic character to the Green Pond of New Jersey, is also announced.

*Characteristics of the Older Crystallines of Southeastern New York:* Charles P. Berkey, Columbia University.

There are but three well-established formations belonging to the completely metamorphosed series of the vicinity of New York City. These are:

(*a*) Fordham gneiss and its associates (oldest).

(*b*) Inwood limestone.

(*c*) Manhattan schist (youngest).

The Fordham gneiss and Manhattan schist are not always readily distinguished. Certain varieties of each are alike in every essential character, and if the evidence is confined to these varieties no determination can be made. This is especially true of the intrusive members.

A study of thousands of cases where discrimination between these two formations was necessary has convinced the writer that the most constant characters of the Manhattan schist in order of importance are:

(*a*) The presence of a white pearly mica.

(*b*) Coarse foliation.

(*c*) A crumpled structure.

And in contrast the most constant Fordham gneiss characters are:

(*a*) A banded structure.

(*b*) Close granular or granitoid texture merging into foliation.

(*c*) Abundance of feldspathic constituents.

During the past year a study of Manhattan Island, especially the covered portion of the southern third, and adjacent areas southward on Long Island, has been made by means of an examination of all drill borings whose materials could be seen—several hundred in all. Discrimination by the above criteria indicates a much more complex structure and areal distribution than formerly mapped. Both gneiss and limestone are represented in these southerly areas. Recent borings placed for the purpose of testing this structure have proved the case beyond any question by penetrating both of these formations at points indicated by this interpretation.

Edgar T. Wherry,
*Secretary*